

PENTON & RODGERS

WE CLAIM:

- 1           1. A method of generating ultraviolet light,  
2 comprising the steps of:
  - 3           tuning a neodymium-doped yttrium aluminum garnet  
4 crystal laser to output a first fundamental beam at  
5 approximately 946 nanometers;
  - 6           doubling the frequency of the first fundamental  
7 beam to produce a second harmonic beam having a wavelength  
8 of approximately 473 nanometers; and
  - 9           producing a fourth harmonic beam having a  
10 wavelength of approximately 236.5 nanometers by doubling the  
11 frequency of the second harmonic beam using a first cesium  
12 lithium borate crystal oriented for non-critical phase-  
13 matching.
- 1           2. The method of claim 1, further comprising the  
2 step of cooling the first cesium lithium borate crystal to  
3 between -10 degrees centigrade and -20 degrees centigrade.
- 1           3. The method of claim 1, further comprising the  
2 step of disposing the first cesium lithium borate crystal in  
3 a container of dry inert gas.
- 1           4. The method of claim 1, further comprising the  
2 step of disposing the first cesium lithium borate crystal in  
3 a vacuum.
- 1           5. The method of claim 1, further comprising the  
2 step of confocal focusing of the second harmonic beam into  
3 the first cesium lithium borate crystal.
- 1           6. The method of claim 1, further comprising the  
2 steps of:

3           tuning a rare earth doped garnet laser to emit a  
4   second fundamental beam at a wavelength of approximately  
5   1077 nanometers;

6           directing the second fundamental beam and the  
7   fourth harmonic beam to a second cesium lithium borate  
8   crystal; and

9           sum-frequency mixing the second fundamental beam  
10   and the fourth harmonic beam in the second cesium lithium  
11   borate crystal to produce an output beam at approximately  
12   194 nanometers.

1           7. The method of claim 3, wherein the dry inert  
2   gas is selected from the group consisting of nitrogen, dry  
3   air, helium, neon, argon, krypton and xenon.

1           8. An apparatus for generating ultraviolet  
2   light, comprising:

3           means for tuning a neodymium-doped yttrium  
4   aluminum garnet crystal to output a first fundamental beam  
5   at approximately 946 nanometers;

6           means for doubling the frequency of the  
7   fundamental beam to produce a second harmonic beam having a  
8   wavelength of approximately 473 nanometers; and

9           means for producing a fourth harmonic beam having  
10   a wavelength of approximately 236.5 nanometers by doubling  
11   the frequency of the second harmonic beam using a first  
12   cesium lithium borate crystal oriented for non-critical  
13   phase-matching.

1           9. The apparatus of claim 8, further comprising  
2   means for cooling the first cesium lithium borate crystal to  
3   between -10 degrees centigrade and -20 degrees centigrade.

1           10. The apparatus of claim 8, further comprising  
2 means for disposing the first cesium lithium borate crystal  
3 in dry inert gas.

1           11. The apparatus of claim 8, further comprising  
2 means for disposing the first cesium lithium borate crystal  
3 in a vacuum.

1           12. The apparatus of claim 8, further comprising  
2 means for confocal focusing of the second harmonic beam into  
3 the first cesium lithium borate crystal.

1           13. The apparatus of claim 8, further comprising:  
2           means for emitting a second fundamental beam at a  
3 wavelength of approximately 1077 nanometers;  
4           means for directing the second fundamental beam  
5 and the fourth harmonic beam to a second cesium lithium  
6 borate crystal; and  
7           means for tuning the second cesium lithium borate  
8 crystal to sum-frequency mix the second fundamental beam and  
9 the fourth harmonic beam to produce an output beam at  
10 approximately 194 nanometers.

1           14. The apparatus of claim 10, wherein the dry  
2 inert gas is selected from the group consisting of nitrogen,  
3 dry air, helium, neon, argon, krypton and xenon.

1           15. An apparatus for generating ultraviolet  
2 light, comprising:  
3           an active laser medium comprising a garnet crystal  
4 doped with a rare earth element;  
5           a diode pump laser for pumping the active laser  
6 medium;

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7           a resonator for generating a fundamental beam  
8   having a wavelength of approximately 946 nanometers from the  
9   pumped active laser medium;

10           a periodically-poled potassium titanyl phosphate  
11   crystal for producing a second harmonic beam having a  
12   wavelength of approximately 473 nanometers; and

13           a cesium lithium borate crystal cooled to a  
14   temperature in the range from -10° centigrade to -20°  
15   centigrade and oriented for non-critical phase-matching, for  
16   producing a fourth harmonic beam having a wavelength of  
17   approximately 237 nanometers.

1           16. The apparatus of claim 15, wherein the active  
2   laser medium comprises a neodymium-doped yttrium aluminum  
3   garnet crystal.

1           17. The apparatus of claim 16, wherein the  
2   neodymium-doped yttrium aluminum garnet crystal comprises a  
3   first un-doped end portion, a doped central portion and a  
4   second un-doped end portion.

1           18. An apparatus for generating ultraviolet  
2   light, comprising:

3           an Nd:LiYF<sub>4</sub> laser tuned to output a fifth harmonic  
4   beam at approximately 209 nanometers;

5           a garnet laser doped with a rare earth element and  
6   tuned to output a fundamental beam at approximately 1305  
7   nanometers; and

8           a cesium lithium borate crystal for sum-frequency  
9   mixing the fundamental beam and the fifth harmonic beam to  
10   produce an output beam at approximately 180 nanometers.